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Correlation Testing of the European EMA (Engine Manufacturers Association) Round Robin Engine (Daimler-Benz OM 366 A) Heavy-Duty Engine Testing Report

(U.S.) Environmental Protection Agency
Ann Arbor, MI

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16. ABSTRACT

This report examines the results of testing the Daimler-Benz OM 366 A heavy-duty engine at the Environmental Protection Agency Motor Vehicle Emission Laboratory. This heavy-duty engine was tested for the purpose of providing correlation data for the comparison with similar data developed by European engine manufacturers. The Environmental Protection Agencies' Selective Enforcement Audit (SEA) program requires correlation testing to take place between EPA's MVEL heavy-duty engine testing facility and that of the manufacturer who produces engines for sale in the United States. In order to comply with the SEA program's facility correlation requirement, the European EMA members organized a round robin testing program. They decided to test a Daimler-Benz OM 366A engine, and to focus the program on gathering simple cold start/hot start Federal Test Procedure data.

This report includes the results of the tests, including engine description, fuels, test procedures and test plans.

17. KEY WORDS AND DOCUMENT ANALYSIS

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Correlation Testing of the European EMA Round Robin Engine (Daimler-Benz OM 366A)

I. Introduction

The Environmental Protection Agencies' Selective Enforcement Audit (SEA) program requires correlation testing to take place between EPA's MVEL heavy duty (HD) engine testing facility and that of the manufacturer who produces engines for sale in the United States. There are five European manufactures of HD engines that participate in the U.S. market and have their own HD testing facility in Europe. These manufacturers are members of the Engine Manufacturers Association (EMA) and are referred to as "European EMA" members.

In order to comply with the SEA program's facility correlation requirement, the European EMA members organized a round robin testing program. They decided to test a Daimler-Benz OM 366A engine, and to focus the program on gathering simple cold start/hot start Federal Test Procedure data. (Such a program contrasts with the U.S. EMA/CRC/EPA program wherein various test procedure questions were addressed in each laboratories' test plans.)

The D-B OM 366A engine was selected in part because it did not require a charge air cooler system, which is cumbersome to transport and set up at various facilities, and partly because this particular engine had been tested once already at the EPA/MVEL.

The engine was circulated among the five European EMA laboratories in the spring and early summer of 1987. It was then shipped to the EPA/MVEL in mid summer, 1987. The engine was tested at the MVEL in the first weeks of September, 1987 and was subsequently returned to Daimler-Benz. (This engine may be used for a second round of testing among the European EMA laboratories.) The purpose of this report is to present and discuss the results of the EPA testing of the D-B OM 366A. The comparisons will be with the most recent D-B testing. The comparison with the results observed in the other four European EMA laboratories will be presented in a different report. Some limited comparisons will be made to the previous EPA and D-B test program which was reported in EPA report EPA-AA-SDSB-86-02.

II. Engine Test Procedures and Fuels

The 1984 Daimler-Benz OM 366A is an in-line, 6 cylinder, direct injection, turbocharged, four-stroke per cycle diesel engine. It is rated at 171 hp at 2600 rpm. The engine was

tested at the MVEL facility with all normal Federal Test Procedures adhered to. Three cold start and six hot start transient tests were run as well as two sets of four steady state modes. Copies of the individual transient test and steady state test results are included in the Appendix. Phillips DOE reference Fuel (lot G-668) was used during the test, and a copy of the fuel analysis is included in the Appendix. Dilution tunnel flow rate was 3000 CFM, and inlet fuel temperature was limited to 110°F. The shut down procedure employed was fuel pump shut off and simultaneous dynamometer dial-down.

III. Test Results

The initial part of testing HD engines is to map the wide open throttle torque characteristics of the engine as a function of speed. This data is then used to denormalize the engine operating cycle to form the engine reference cycle. One way to compare this process between laboratories is to look at the subsequent integrated reference brake horsepower-hour figure. If both labs have the same map results (which can be indicated by the engine performance values of idle speed, peak torque, peak torque speed and rated power) then both labs should have the same integrated reference brake horsepower-hour figure, provided of course, the denormalization process was done correctly.

The engine performance test results (see Table 1) measured at MVEL show close agreement to results previously obtained with this engine (see EPA-AA-SDSB-86-02), and in addition, are in good agreement with current Daimler-Benz results in the areas of rated power, maximum torque speed, and maximum torque output of this engine. In the previous correlation testing, integrated reference horsepower results between EPA and Daimler-Benz were in very good agreement, in line with the rest of the engine performance results. Daimler-Benz results for the current cycle of correlation tests shows a 3.4 percent increase in integrated reference horsepower from previous D-B results and is 4.2 percent higher than the current EPA integrated reference horsepower. This is unexpected and not understood considering the consistency in the engine performance data.

The transient emissions data are presented in Tables 2, 3 and 4, which contain the composite, cold start, and hot start data, respectively. The repeatability of the EPA data is generally very good with coefficients of variation (COV) well within the expected values. The only exception to this is the COV for particulate which is about seven percent. This is at the high end of what is usually expected for particulate emissions.

As for comparisons between laboratories, the composite data will be emphasized, as it is representative of the whole data set. The HC levels measured at MVEL were an average of 0.98 g/BHP-hr. The D-B HC values were about 11 percent higher than this, or 1.09 g/BHP-hr. When EPA previously tested this engine, the HC values were significantly higher than either the current EPA values or the D-B HC value. The reasons for this variability are not understood at this time.

With regard to the other emissions, there was very good agreement between labs in NOx values. The CO, particulate and BSFC values were all higher at the D-B lab than the MVEL and the magnitude of the difference between labs was near the upper limit of what one would expect for these measurements. In other words, the agreement on these values is marginal but probably acceptable.

IV. Conclusions

In summary, EPA tested the Daimler-Benz OM 366A engine for correlation with results from five European EMA laboratories. The comparisons discussed in the report are with D-B data. The conclusions from this work are:

1. Average composite transient test results were, in g/BHP-hr, 0.98 HC, 2.42 CO, 7.82 NOx, 0.44 PM, and 0.400 lb/BHP-hr BSFC.

2. There was close agreement between the EPA and D-B laboratories on engine performance data, and differences are minimal when compared to the same data from the previous testing of this engine by the same two facilities. EPA's data for integrated reference BHP-hr changed by -1.2 percent from the previous test to this one, but Daimler-Benz had a change of +3.4 percent. This change is not expected considering the close agreement of all other performance data and is unexplained.

3. In comparing emissions between the two labs, the following conclusions were reached:

- HC values from this engine appear quite variable as previous EPA testing had results much higher than D-B. Current testing shows D-B results to be about 11 percent higher than EPA. The reasons for this are not known.

- NOx correlation between labs was excellent (less than 1 percent difference).

- CO, particulate and BSFC values were all higher at D-B than at EPA and in magnitude were at the upper limit of what would be considered good lab-to-lab correlation.

Table 1

Table of Engine Performance Data from Testing of the Daimler-Benz OM 366A Correlation Engine

Lab	Curb Idle, RPM	Max. Power		Max. Torque Point		Integrated Reference Horsepower, BHP-hr
		BHP	Speed, RPM	Speed, RPM	Torque, Ft.- lb.	
EPA	600	171	2583	1556	403	10.845
D-B	600	171	2600	1560	408	11.30

Table 2

Table of Composite Transient Test Emission Results From the European EMA Round Robin Correlation Engine (D-B OM 366A)

Test No.	Emissions, g/BHP-Hr HC	CO	NOx	Part	BSFC, lb/BHP-Hr
3690					
3691	0.99	2.50	7.66	0.44	0.387
3694					
3695	1.01	2.41	8.10	0.47	0.412
3699					
3700	0.94	2.34	7.69	0.41	0.402
$\bar{X}$	0.98	2.42	7.82	0.44	0.400
$(S/\bar{X})100$	3.8	3.3	3.2	6.8	3.1
D-B $\bar{X}$	1.09	2.60	7.75	0.48	0.413
% Difference Relative to EPA					
	+11.2	+7.4	-.9	+9.1	+3.3

Table 3

Table of Cold Start Emission Results from the European EMA Round Robin Correlation Engine (D-B OM 366A)

Test No.	Emissions, g/BHP-Hr				BSFC, lb/BHP-Hr
	HC	CO	NOx	Part	
3690	1.25	3.04	8.07	0.51	0.390
3694	1.27	3.10	8.60	0.50	0.427
3699	1.27	3.27	7.95	0.48	0.418
$\bar{X}$	1.26	3.14	8.21	0.50	0.412
$(S/\bar{X})100$	1.1	3.8	4.2	3.1	4.7
D-B $\bar{X}$	1.30	3.25	7.81	0.57	0.428
% Difference Relative to EPA					
	+2.8	+3.5	-4.8	+14.0	+3.9

*3 tests

Table 4

Table of Hot Start Emission Results from the European EMA Round Robin Correlation Engine (D-B OM 366A)

Test No.	Emissions, g/BHP-Hr				BSFC, lb/BHP-Hr
	HC	CO	NOx	Part	
3691	0.95	2.41	7.59	0.43	0.387
3692	1.01	2.29	7.68	0.47	0.384
3693	0.99	2.17	7.43	0.47	0.377
3695	0.97	2.30	8.02	0.46	0.409
3696	0.97	2.35	8.14	0.43	0.408
3697	0.98	2.27	8.01	0.40	0.408
3700	0.88	2.19	7.65	0.40	0.399
3701	0.97	2.29	7.75	0.40	0.398
3702	0.87	2.22	7.85	0.40	0.395
$\bar{X}$	0.95	2.28	7.79	0.43	0.396
$(S/\bar{X})100$	4.8	3.3	3.0	7.2	2.9
D-B $\bar{X}$	1.05	2.45	7.69	0.47	0.406
% Difference Relative to EPA					
	+10.1	+7.5	-1.3	+9.3	+2.5

*3 tests

Appendix Contents

EPA Map Data

EPA Transient Test Summary Sheets

EPA Steady State Summary Table

Fuel Analysis

Daimler-Benz Data

- Engine Set-up Data
- Transient Test Results
- Steady State Test Results (4-Mode)
- Smoke Results
- Steady State Test Results (8-Modes)

A 2

Data Points From Mapping of the
D-B OM 366 A European Round Robin
Engine on July 30, 1987 at
the EPA-MVEL
Speed in RPM
Torque in ft-lb

THERE ARE (302) MAPPING DATA POINTS:

554.	202.0	922.	339.2	1291.	378.8	1661.	400.4	2031.	375.2	2400.	357.2
558.	207.6	929.	336.8	1299.	380.8	1670.	401.6	2037.	375.2	2408.	357.2
561.	220.0	937.	334.4	1306.	381.6	1677.	402.0	2046.	375.6	2415.	357.6
566.	226.8	945.	334.0	1315.	381.6	1683.	402.0	2053.	374.8	2423.	356.0
582.	234.0	952.	334.8	1321.	384.4	1691.	402.4	2061.	374.4	2430.	355.6
592.	240.4	958.	334.4	1328.	384.8	1697.	399.6	2068.	374.4	2437.	355.2
598.	248.8	965.	334.8	1335.	386.4	1704.	397.2	2075.	374.4	2445.	354.8
605.	252.0	974.	336.4	1343.	386.8	1711.	395.6	2083.	375.2	2451.	355.2
615.	254.0	981.	337.2	1351.	388.0	1721.	393.6	2090.	374.0	2460.	354.4
620.	257.2	989.	339.2	1360.	391.6	1727.	390.8	2096.	373.6	2467.	354.0
629.	258.8	996.	339.2	1366.	390.4	1736.	388.8	2104.	373.2	2473.	353.2
635.	261.6	1003.	339.6	1374.	390.0	1741.	388.0	2112.	374.4	2479.	352.4
641.	263.6	1009.	340.4	1381.	392.0	1749.	385.6	2119.	373.6	2488.	351.2
648.	264.8	1018.	340.4	1388.	393.2	1756.	384.8	2126.	374.0	2496.	351.6
657.	267.6	1025.	340.0	1394.	393.2	1764.	384.4	2134.	372.8	2504.	351.2
664.	270.0	1033.	339.2	1404.	391.6	1771.	386.8	2142.	371.6	2512.	351.6
671.	271.6	1040.	339.6	1411.	392.8	1780.	386.4	2150.	371.2	2520.	351.2
677.	273.6	1047.	341.2	1416.	392.4	1786.	387.2	2156.	370.0	2527.	350.8
688.	274.4	1055.	342.0	1423.	393.2	1794.	384.0	2163.	368.4	2534.	350.0
693.	275.6	1062.	342.0	1432.	394.0	1801.	382.4	2170.	367.6	2540.	349.6
700.	277.2	1069.	342.8	1439.	394.8	1809.	382.8	2178.	367.6	2549.	348.4
708.	278.4	1077.	342.4	1448.	395.6	1816.	382.4	2185.	366.4	2557.	348.4
715.	281.2	1084.	343.2	1454.	396.0	1824.	382.0	2194.	366.0	2563.	348.0
721.	282.8	1091.	342.8	1462.	397.6	1831.	380.8	2200.	365.2	2570.	347.6
729.	284.4	1097.	342.4	1467.	398.0	1838.	380.4	2207.	364.4	2577.	345.6
737.	286.0	1106.	342.8	1476.	398.8	1846.	379.6	2214.	364.0	2585.	345.6
748.	289.2	1113.	343.2	1484.	398.4	1853.	380.0	2223.	363.6	2593.	345.6
752.	290.4	1120.	344.0	1492.	400.0	1860.	380.0	2230.	363.6	2601.	342.4
760.	292.8	1129.	344.8	1499.	400.8	1868.	378.4	2238.	363.6	2609.	342.4
766.	293.6	1136.	345.6	1506.	402.0	1876.	378.0	2244.	364.0	2615.	341.6
775.	295.2	1144.	346.4	1512.	401.6	1881.	376.8	2252.	362.8	2623.	341.2
781.	297.2	1151.	347.6	1521.	401.6	1890.	375.6	2260.	362.4	2629.	340.0
790.	299.2	1158.	349.2	1527.	402.0	1897.	375.6	2268.	362.4	2637.	338.8
797.	302.4	1166.	350.8	1536.	402.0	1904.	374.8	2273.	362.0	2644.	336.8
806.	304.8	1174.	352.4	1543.	402.4	1913.	374.4	2281.	360.8	2651.	336.4
810.	305.2	1180.	354.0	1550.	402.8	1919.	373.6	2289.	360.4	2659.	334.4
818.	307.6	1189.	355.6	1556.	402.8	1926.	373.6	2297.	360.4	2666.	330.4
825.	309.6	1194.	357.6	1565.	402.8	1935.	373.2	2303.	360.8	2673.	325.2
832.	312.8	1202.	358.8	1572.	399.6	1941.	373.2	2311.	360.8	2680.	318.4
841.	315.6	1210.	361.6	1579.	399.2	1951.	373.6	2318.	360.8	2688.	310.0
848.	318.4	1217.	363.6	1587.	399.2	1958.	374.0	2327.	360.0	2694.	301.2
857.	323.2	1225.	364.8	1594.	398.4	1965.	373.6	2334.	360.8	2699.	290.4
864.	326.0	1233.	366.4	1602.	398.0	1970.	374.8	2341.	362.8	2707.	276.4
870.	327.2	1240.	369.6	1608.	398.8	1978.	374.4	2347.	361.6	2715.	276.4
878.	329.6	1247.	370.4	1616.	400.0	1986.	374.0	2356.	360.4	2723.	259.2
885.	331.6	1254.	372.0	1624.	400.4	1995.	374.0	2365.	359.2	2731.	246.8
892.	333.2	1262.	374.8	1632.	400.8	2002.	374.8	2369.	359.2	2738.	237.2
901.	335.2	1269.	375.2	1638.	400.4	2009.	374.8	2378.	359.2	2747.	224.4
907.	336.8	1277.	376.8	1645.	400.8	2015.	376.0	2384.	359.2	2753.	213.6
913.	338.4	1284.	377.6	1654.	401.6	2023.	375.6	2393.	358.0	2756.	204.8
										2758.	202.0
										2759.	196.0

<COMMENT> MAX POWER: 170.6 HP @ 2593. RPM.
<COMMENT> RATED SPEED: 2583. RPM.
WANT A CALCOMP PLOT OF THE MAPPING CURVE? (Y/N). (DEFLT = N): Y

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873690 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 7-31-87 8: 7 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 78.50 F
ABSOLUTE HUMIDITY: 64.52 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	3.96	0.00	
EXHAUST+BKG, GM	17.00	0.00	
NET, GM/BHP-HR	1.248	0.000	1.248
CO (BAG)			
BACKGROUND, PPM	0.25	0.00	
EXHAUST+BKG, GM	33.26	0.00	
NET, GM/BHP-HR	3.04	0.00	3.04
NOX (INTEGRATED)			
BACKGROUND, PPM	0.26	0.00	
EXHAUST+BKG, GM	90.17	0.00	
NET, GM/BHP-HR	8.071	0.000	8.071
CO2 (BAG)			
BACKGROUND, PPM	0.040	0.000	
EXHAUST+BKG, GM	7132.58	0.00	
NET, GM/BHP-HR	555.6	0.0	555.6
PARTICULATE			
SECONDARY TARE, GM	0.159824	0.000000	
SECONDARY PART, GM	0.160052	0.000000	
PRIMARY TARE, GM	0.155473	0.000000	
PRIMARY PART, GM	0.159136	0.000000	
TOTAL, GM/BHP-HR	0.51	0.00	0.51
FUEL CONSUMPTION			
LBS/CARBON BALANCE	4.211	0.000	4.211
LBS/BHP-HR	0.390	0.000	0.390
LBS/MEASURED	4.476	0.0	
BRAKE HORSEPOWER-HOUR	10.783	0.000	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	0
SLOPE	1.00397	0.00000
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	-8.152	0.000
(LIMIT: +-50 RPM)		
STD ERROR	11.987	0.000
(LIMIT: 100 RPM)		
R-SQUARE	0.99979	0.00000
(LIMIT: 0.97)		
TORQUE		
NUMBER	983	0
SLOPE	1.00795	0.00000
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	-3.033	0.000
(LIMIT: +-15 FT-LBS)		
STD ERROR	3.792%	0.000%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.98397	0.00000
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	982	0
SLOPE	1.01365	0.00000
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	-1.196	0.000
(LIMIT: +-5 BHP)		
STD ERROR	3.261%	0.000%
(LIMIT: 8%)		
R-SQUARE	0.98787	0.00000
(LIMIT: 0.91)		
WORK		
ACTUAL	10.783	0.000
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	10.845	0.000
% DIFFERENCE	-0.57%	0.00%

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DIESEL SUMMARY REPORT

TEST NUMBER: HD-873691
TEST DATE/TIME: 7-31-87 9:33
MANUFACTURER: MERCEDES BENZ
ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 79.00 F
ABSOLUTE HUMIDITY: 56.72 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	14.12	
NET, GM/BHP-HR	0.000	0.949	0.949
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	26.06	
NET, GM/BHP-HR	0.00	2.41	2.41
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	86.66	
NET, GM/BHP-HR	0.000	7.587	7.587
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	7051.15	
NET, GM/BHP-HR	0.0	553.2	553.2
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.147306	
SECONDARY PART, GM	0.000000	0.147417	
PRIMARY TARE, GM	0.000000	0.143940	
PRIMARY PART, GM	0.000000	0.147225	
TOTAL, GM/BHP-HR	0.00	0.43	0.43
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.188	4.188
LBS/BHP-HR	0.000	0.387	0.387
LBS/MEASURED	0.0	4.404	
BRAKE HORSEPOWER-HOUR	0.000	10.809	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00422
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-8.506
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.750
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99980
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	989
SLOPE	0.00000	1.00725
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-2.533
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.767%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98442
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	988
SLOPE	0.00000	1.01440
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.157
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.281%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98802
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.809
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	-0.33%

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DIESEL SUMMARY REPORT

TEST NUMBER: HD-873692 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 7-31-87 10:13 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 77.50 F
ABSOLUTE HUMIDITY: 63.96 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.73	
EXHAUST+BKG, GM	0.00	14.18	
NET, GM/BHP-HR	0.000	1.005	1.005
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	24.70	
NET, GM/BHP-HR	0.00	2.29	2.29
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.51	
EXHAUST+BKG, GM	0.00	86.77	
NET, GM/BHP-HR	0.000	7.679	7.679
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.037	
EXHAUST+BKG, GM	0.00	6978.35	
NET, GM/BHP-HR	0.0	547.8	547.8
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.154690	
SECONDARY PART, GM	0.000000	0.154920	
PRIMARY TARE, GM	0.000000	0.149568	
PRIMARY PART, GM	0.000000	0.152887	
TOTAL, GM/BHP-HR	0.00	0.47	0.47
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.141	4.141
LBS/BHP-HR	0.000	0.384	0.384
LBS/MEASURED	0.0	4.404	
BRAKE HORSEPOWER-HOUR	0.000	10.793	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00439
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-8.554
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.921
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99979
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	989
SLOPE	0.00000	1.00844
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-3.118
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.750%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98460
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	988
SLOPE	0.00000	1.01355
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.224
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.281%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98799
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.793
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	-0.48%

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DIESEL SUMMARY REPORT

TEST NUMBER: HD-873693
TEST DATE/TIME: 7-31-87 10:54
MANUFACTURER: MERCEDES BENZ
ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 77.00 F
ABSOLUTE HUMIDITY: 55.42 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.96	
EXHAUST+BKG, GM	0.00	14.25	
NET, GM/BHP-HR	0.000	0.993	0.993
CO (BAG)			
BACKGROUND, PPM	0.00	0.49	
EXHAUST+BKG, GM	0.00	24.37	
NET, GM/BHP-HR	0.00	2.17	2.17
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	1.02	
EXHAUST+BKG, GM	0.00	87.31	
NET, GM/BHP-HR	0.000	7.430	7.430
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.037	
EXHAUST+BKG, GM	0.00	6878.87	
NET, GM/BHP-HR	0.0	538.4	538.4
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.158636	
SECONDARY PART, GM	0.000000	0.158848	
PRIMARY TARE, GM	0.000000	0.148620	
PRIMARY PART, GM	0.000000	0.151926	
TOTAL, GM/BHP-HR	0.00	0.47	0.47
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.069	4.069
LBS/BHP-HR	0.000	0.377	0.377
LBS/MEASURED	0.0	4.404	
BRAKE HORSEPOWER-HOUR	0.000	10.792	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00379
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-8.008
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.969
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99979
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	989
SLOPE	0.00000	1.00693
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-2.882
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.758%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98449
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	988
SLOPE	0.00000	1.01251
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.181
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.284%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98795
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.792
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	-0.49%

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST DATE: 08-07-87 TIME: 14:19:08 HD-873694

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873694 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 8- 5-87 8:12 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 78.00 F
ABSOLUTE HUMIDITY: 65.85 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	2.61	0.00	
EXHAUST+BKG, GM	16.05	0.00	
NET, GM/BHP-HR	1.272	0.000	1.272
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	33.44	0.00	
NET, GM/BHP-HR	3.10	0.00	3.10
NOX (INTEGRATED)			
BACKGROUND, PPM	0.26	0.00	
EXHAUST+BKG, GM	95.78	0.00	
NET, GM/BHP-HR	8.602	0.000	8.602
CO2 (BAG)			
BACKGROUND, PPM	0.034	0.000	
EXHAUST+BKG, GM	7521.38	0.00	
NET, GM/BHP-HR	607.6	0.0	607.6
PARTICULATE			
SECONDARY TARE, GM	0.154596	0.000000	
SECONDARY PART, GM	0.154652	0.000000	
PRIMARY TARE, GM	0.151457	0.000000	
PRIMARY PART, GM	0.155264	0.000000	
TOTAL, GM/BHP-HR	0.50	0.00	0.50
FUEL CONSUMPTION			
LBS/CARBON BALANCE	4.602	0.000	4.602
LBS/BHP-HR	0.427	0.000	0.427
LBS/MEASURED	4.618	0.0	
BRAKE HORSEPOWER-HOUR	10.789	0.000	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	0
SLOPE	1.00506	0.00000
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	-7.776	0.000
(LIMIT: +-50 RPM)		
STD ERROR	11.958	0.000
(LIMIT: 100 RPM)		
R-SQUARE	0.99979	0.00000
(LIMIT: 0.97)		
TORQUE		
NUMBER	980	0
SLOPE	1.01534	0.00000
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	-4.402	0.000
(LIMIT: +-15 FT-LBS)		
STD ERROR	3.749%	0.000%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.98442	0.00000
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	979	0
SLOPE	1.01723	0.00000
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	-1.321	0.000
(LIMIT: +-5 BHP)		
STD ERROR	3.284%	0.000%
(LIMIT: 8%)		
R-SQUARE	0.98769	0.00000
(LIMIT: 0.91)		
WORK		
ACTUAL	10.789	0.000
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	10.845	0.000
% DIFFERENCE	-0.52%	0.00%

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HEAVY DUTY DIESEL TRANSIENT ENGINE TEST DATE: 08-07-87 TIME: 14:19:24 HD-873695

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873695 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 8- 5-87 9: 3 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 77.50 F
ABSOLUTE HUMIDITY: 59.52 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.36	
EXHAUST+BKG, GM	0.00	13.44	
NET, GM/BHP HR	0.000	0.966	0.966
CO (BAG)			
BACKGROUND, PPM	0.00	0.25	
EXHAUST+BKG, GM	0.00	25.37	
NET, GM/BHP HR	0.00	2.30	2.30
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.51	
EXHAUST+BKG, GM	0.00	91.67	
NET, GM/BHP HR	0.000	8.019	8.019
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.035	
EXHAUST+BKG, GM	0.00	7342.91	
NET, GM/BHP HR	0.0	584.5	584.5
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.159875	
SECONDARY PART, GM	0.000000	0.160150	
PRIMARY TARE, GM	0.000000	0.163171	
PRIMARY PART, GM	0.000000	0.166357	
TOTAL, GM/BHP-HR	0.00	0.46	0.46
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.420	4.420
LBS/BHP-HR	0.000	0.409	0.409
LBS/MEASURED	0.0	4.476	
BRAKE HORSEPOWER-HOUR	0.000	10.808	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00445
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-7.842
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.702
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99980
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	988
SLOPE	0.00000	1.00895
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-3.003
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.756%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98454
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	987
SLOPE	0.00000	1.01455
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.185
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.268%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98812
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.808
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	-0.34%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873696 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 8- 5-87 9:42 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 77.00 F
ABSOLUTE HUMIDITY: 62.72 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.36	
EXHAUST+BKG, GM	0.00	13.45	
NET, GM/BHP-HR	0.000	0.967	0.967
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	25.40	
NET, GM/BHP-HR	0.00	2.35	2.35
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.26	
EXHAUST+BKG, GM	0.00	91.47	
NET, GM/BHP-HR	0.000	8.141	8.141
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.037	
EXHAUST+BKG, GM	0.00	7362.77	
NET, GM/BHP-HR	0.0	582.8	582.8
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.166481	
SECONDARY PART, GM	0.000000	0.166595	
PRIMARY TARE, GM	0.000000	0.166450	
PRIMARY PART, GM	0.000000	0.169742	
TOTAL, GM/BHP-HR	0.00	0.43	0.43
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.404	4.404
LBS/BHP-HR	0.000	0.408	0.408
LBS/MEASURED	0.0	4.476	
BRAKE HORSEPOWER-HOUR	0.000	10.798	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00373
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-7.468
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.832
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99979
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	985
SLOPE	0.00000	1.00929
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-2.987
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.725%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98466
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	984
SLOPE	0.00000	1.01414
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.174
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.281%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98790
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.798
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	-0.43%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873697 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 8- 5-87 10:22 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 77.50 F
ABSOLUTE HUMIDITY: 61.88 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	13.48	
NET, GM/BHP-HR	0.000	0.982	0.982
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	24.53	
NET, GM/BHP-HR	0.00	2.27	2.27
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	90.27	
NET, GM/BHP-HR	0.000	8.012	8.012
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	7364.38	
NET, GM/BHP-HR	0.0	582.3	582.3
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.158591	
SECONDARY PART, GM	0.000000	0.158680	
PRIMARY TARE, GM	0.000000	0.162416	
PRIMARY PART, GM	0.000000	0.165466	
TOTAL, GM/BHP-HR	0.00	0.40	0.40
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.403	4.403
LBS/BHP-HR	0.000	0.408	0.408
LBS/MEASURED	0.0	4.404	
BRAKE HORSEPOWER-HOUR	0.000	10.803	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00446
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-8.174
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.921
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99979
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	988
SLOPE	0.00000	1.01076
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-3.450
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.725%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98484
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	987
SLOPE	0.00000	1.01570
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.245
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.267%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98816
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.803
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	-0.39%

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST DATE: 08-07-87 TIME: 14:19:54 HD-873699

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873699 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 8- 6-87 8:45 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 74.00 F
ABSOLUTE HUMIDITY: 48.22 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	3.88	0.00	
EXHAUST+BKG, GM	17.25	0.00	
NET, GM/BHP-HR	1.271	0.000	1.271
CO (BAG)			
BACKGROUND, PPM	0.25	0.00	
EXHAUST+BKG, GM	35.84	0.00	
NET, GM/BHP-HR	3.27	0.00	3.27
NOX (INTEGRATED)			
BACKGROUND, PPM	0.51	0.00	
EXHAUST+BKG, GM	93.44	0.00	
NET, GM/BHP-HR	7.947	0.000	7.947
CO2 (BAG)			
BACKGROUND, PPM	0.036	0.000	
EXHAUST+BKG, GM	7485.08	0.00	
NET, GM/BHP-HR	595.5	0.0	595.5
PARTICULATE			
SECONDARY TARE, GM	0.168294	0.000000	
SECONDARY PART, GM	0.168450	0.000000	
PRIMARY TARE, GM	0.163520	0.000000	
PRIMARY PART, GM	0.167144	0.000000	
TOTAL, GM/BHP-HR	0.48	0.00	0.48
FUEL CONSUMPTION			
LBS/CARBON BALANCE	4.524	0.000	4.524
LBS/BHP-HR	0.418	0.000	0.418
LBS/MEASURED	4.547	0.0	
BRAKE HORSEPOWER-HOUR	10.812	0.000	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	0
SLOPE	1.00432	0.00000
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	-6.188	0.000
(LIMIT: +-50 RPM)		
STD ERROR	11.903	0.000
(LIMIT: 100 RPM)		
R-SQUARE	0.99979	0.00000
(LIMIT: 0.97)		
TORQUE		
NUMBER	984	0
SLOPE	1.00416	0.00000
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	-2.229	0.000
(LIMIT: +-15 FT-LBS)		
STD ERROR	3.886%	0.000%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.98308	0.00000
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	983	0
SLOPE	1.01382	0.00000
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	-1.106	0.000
(LIMIT: +-5 BHP)		
STD ERROR	3.311%	0.000%
(LIMIT: 8%)		
R-SQUARE	0.98755	0.00000
(LIMIT: 0.91)		
WORK		
ACTUAL	10.812	0.000
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	10.845	0.000
% DIFFERENCE	-0.30%	0.00%

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST DATE: 08-07-87 TIME: 14:20:04 HD-873700

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873700
TEST DATE/TIME: 8- 6-87 9:31
MANUFACTURER: MERCEDES BENZ
ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 73.50 F
ABSOLUTE HUMIDITY: 46.95 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	13.83	
NET, GM/BHP-HR	0.000	0.884	0.884
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	23.70	
NET, GM/BHP-HR	0.00	2.19	2.19
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	90.48	
NET, GM/BHP-HR	0.000	7.650	7.650
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	7255.95	
NET, GM/BHP-HR	0.0	570.0	570.0
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.165280	
SECONDARY PART, GM	0.000000	0.165401	
PRIMARY TARE, GM	0.000000	0.166074	
PRIMARY PART, GM	0.000000	0.169113	
TOTAL, GM/BHP-HR	0.00	0.40	0.40
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.321	4.321
LBS/BHP-HR	0.000	0.399	0.399
LBS/MEASURED	0.0	4.333	
BRAKE HORSEPOWER-HOUR	0.000	10.837	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00331
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-5.289
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.797
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99979
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	989
SLOPE	0.00000	1.00190
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-1.281
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.795%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98404
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	988
SLOPE	0.00000	1.01330
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.020
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.301%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98785
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.837
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	-0.07%

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST DATE: 08-07-87 TIME: 14:20:14 HD-873701

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873701 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 8- 6-87 10: 0 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 73.50 F
ABSOLUTE HUMIDITY: 46.77 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	4.63	
EXHAUST+BKG, GM	0.00	14.65	
NET, GM/BHP-HR	0.000	0.970	0.970
CO (BAG)			
BACKGROUND, PPM	0.00	0.49	
EXHAUST+BKG, GM	0.00	25.59	
NET, GM/BHP-HR	0.00	2.29	2.29
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.51	
EXHAUST+BKG, GM	0.00	91.34	
NET, GM/BHP-HR	0.000	7.751	7.751
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.036	
EXHAUST+BKG, GM	0.00	7188.09	
NET, GM/BHP-HR	0.0	568.2	568.2
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.163824	
SECONDARY PART, GM	0.000000	0.163951	
PRIMARY TARE, GM	0.000000	0.164306	
PRIMARY PART, GM	0.000000	0.167281	
TOTAL, GM/BHP-HR	0.00	0.40	0.40
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.293	4.293
LBS/BHP-HR	0.000	0.398	0.398
LBS/MEASURED	0.0	4.333	
BRAKE HORSEPOWER-HOUR	0.000	10.794	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00407
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-7.405
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.937
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99979
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	989
SLOPE	0.00000	1.00571
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-2.636
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.794%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98416
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	988
SLOPE	0.00000	1.01309
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.177
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.316%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98773
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.794
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	-0.47%

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST DATE: 08-07-87 TIME: 14:20:23 HD-873702

DIESEL SUMMARY REPORT

TEST NUMBER: HD-873702 MANUFACTURER: MERCEDES BENZ
TEST DATE/TIME: 8- 6-87 10:39 ENGINE ID: 200 OM366A84SEACORR1 1

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 74.00 F
ABSOLUTE HUMIDITY: 47.31 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	13.73	
NET, GM/BHP-HR	0.000	0.874	0.874
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	25.03	
NET, GM/BHP-HR	0.00	2.22	2.22
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	92.01	
NET, GM/BHP-HR	0.000	7.847	7.847
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	7108.05	
NET, GM/BHP-HR	0.0	565.3	565.3
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.166293	
SECONDARY PART, GM	0.000000	0.166418	
PRIMARY TARE, GM	0.000000	0.166231	
PRIMARY PART, GM	0.000000	0.169284	
TOTAL, GM/BHP-HR	0.00	0.40	0.40
FUEL CONSUMPTION			
LBS/CARBON BALANCE	0.000	4.290	4.290
LBS/BHP-HR	0.000	0.395	0.395
LBS/MEASURED	0.0	4.333	
BRAKE HORSEPOWER-HOUR	0.000	10.846	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	1.00362
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	-6.515
(LIMIT: +-50 RPM)		
STD ERROR	0.000	11.966
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99979
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	989
SLOPE	0.00000	0.99282
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	0.504
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	3.930%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.98258
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	988
SLOPE	0.00000	1.00990
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-0.858
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	3.350%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.98741
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.846
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	10.845
% DIFFERENCE	0.00%	0.01%

Table A-1

Table of Steady State Values from
the European EMA Round Robin
Correlation Engine (D-B OM 366A)

Engine Speed RPM	Engine Torque, Ft.-lb	Fuel Rate, lb/hr		Emissions, g/BHP-Hr**				
		Measured	C.Bal*	HC	CO	NOx	CO_2	Part
2600	307.0	56.46	56.07	.35	.63	9.54	531.15	.25
1600	395.8	41.90	41.10	.22	1.60	10.84	489.29	.39
1600	105.5	12.76	12.80	1.43	2.97	6.82	566.37	.26
572	0	1.06	1.06	(21.97)	(39.65)	(24.77)	(1394.75)	(9.06)

*Carbon Balance

**The 572 RPM, O Ft-lb (idle) mode data are in g/hr.

ENGINEERING OPERATIONS DIVISION
Fuel Analysis Report
Diesel Test Fuel

Supplier: Phillips Chemical Lot G-668
Proposed Use('s): Certification and Heavy Duty Engine Testing
Quantity: 2000 gallon Location: Tank 5
Date placed in service: 4/3/87
Expected date of exhaustion: 5/16/88

Item	Method	Procurement Specifications	CFR 86.113-82 (if different)	Official EOD Values
Distillation	ASTM D 86			
Initial Boiling Point (°F)		345-375	340-400	351
10% recovered Point (°F)		400-440	400-460	422
50% recovered Point (°F)		495-525	470-540	505
90% recovered Point (°F)		580-610	550-610	593
End Point (°F)		630-660	580-660	641
Sulfur (wt%)	ASTM D 2622	0.2-0.4	0.2-0.5	0.34
Flashpoint (°F)	ASTM D 93	130 Min.	154	154
Viscosity @ 40 °C (centistokes	ASTM D 445	2.2-3.2	2.0-3.2	2.52
HC Composition	ASTM D 1319			
Olefins (vol%)		(a)		1.9
Aromatics (vol%)		29 Min.	27 Min.	30.3
Saturates (vol%)		(a)		67.8
Cetane Number	ASTM D 613	43-47	42-50	43.0
Cetane Index	ASTM D 976	43-47	(a)	46.2
Oxidation Stability (mg/100ml)	ASTM D 2274	1.5 Max.	(a)	<0.3
Particulate matter (mg/l)	ASTM D 2276	15 Max.	(a)	<2.5
Weight Fraction Carbon	ASTM D 3343	(a)		0.8689
Net Heat of Combustion (BTU/lb)	ASTM D 3338	(a)		18384
Gravity (°API)	ASTM D 287	33-36	33-37	34.9
Fuel Economy Numerator (grams carbon/gallon)		2750-2806	(a)	2791

(a) No requirements or not addressed

Prepared by: _____ Date: _____
Validated by: _____ Date: _____
Quality Control: _____ Date: _____

Nfz-Motoren-Versuch

Bruehl, 07/03/87
V2VK Stein
Tel.: 711/17-7588

CORRELATION ENGINE FOR EMA EUROPEAN ROUND-ROBIN

ENGINE SET-UP AND DESCRIPTIVE DATA

(1)	Engine Manufacturer:	Daimler-Benz AG
(2)	Engine Type:	OM 366 A
(3)	Displacement:	5.96 l
(4)	Model Year:	1984
(5)	Identification Number:	366.959-10-10205
(6)	Fuel Type:	2D
(7)	Rec.Oil Type:	SAE 15W40 (3.7 - 4.2 gal)
(8)	Curb Idle Speed:	600+-50
(9)	Max.Idle Torque:	320 Nm
(10)	High Idle Speed:	2900 RPM
(11)	Max.Safe Operating Speed:	2950 RPM
(12)	Max.Power:	128 (171 HP)/2600 RPM
(13)	Max.Torque:	555 Nm (408 ft-lbs)/1560 RPM
(14)	Fuel Consumption at Max.Power:	28.6 kg/h (63.1 lbs/hr)
(15)	Fuel Consumption at Max.Torque:	18.8 kg/h (41.4 lbs/hr)
(16)	Injection Timing:	17 deg BTDC
(17)	Exhaust Pipe Configuration:	86 mm Inside Diameter
(18)	Length of Exhaust System:	3.5 m
(19)	Inlet Depression:	2.0 kPa (7.9 in Water) (1)
(20)	Exhaust Backpressure:	6.0 kPa (1.8 in Mercury) (2)
(21)	Hours of Operation:	559 hrs
(22)	Rec.Start-up Procedure:	Production Type Starter
(23)	Cranking Speed:	180 RPM at 20 deg C

(1) Set with Restrictor Valve 2.85 m from Intake Manifold
(2) Set with Restrictor Valve 3.00 m from Turbocharger

Nfz-Motoren-Versuch

Bruehl, 07/03/87
V2VK Stein
Tel.: 711/17-7588

DBAG TEST RESULTS OF OM 366 A CORRELATION ENGINE

A.TRANSIENT CYCLE

Cycle Type	HC	NOX	CO	PM	BSFC [g/BHP-hr]
Cold 1	1.33	7.56	3.36	0.61	190.7
Hot 1	1.09	7.54	2.56	0.50	183.6
Hot 2	1.08	7.62	2.56	0.49	183.6
Hot 3	1.05	7.65	2.38	0.47	182.3
Cold 2	1.28	7.91	3.23	0.57	195.5
Hot 4	1.06	7.72	2.48	0.43	186.2
Hot 5	1.00	7.75	2.54	0.47	185.1
Hot 6	1.04	7.66	2.38	0.46	182.5
Cold 3	1.29	7.97	3.16	0.54	196.5
Hot 7	1.03	7.96	2.45	0.47	189.3
Hot 8	1.05	7.61	2.36	0.45	182.0
Hot 9	1.04	7.70	2.36	0.45	182.1
Average Cold	1.30	7.81	3.25	0.57	194.2
Average Hot	1.05	7.69	2.45	0.47	184.1
Weighted Average	1.09	7.71	2.57	0.48	185.5
2s (P=95%)	0.06	0.24	0.18	0.04	4.8
COV (2s)	5.0%	3.2%	7.0%	9.2%	2.6%

CVS Flow Rate:	1469 SCFM
Average DF:	27.31
Average Intake Air Temperature:	74.3 deg F
Average Humidity:	51.1 gr/lb
Idle Speed:	600 RPM
Reference Cycle Work:	11.30 BHP-hr
Measuring Ranges:	HC 100 ppm (Cold); 50 ppm (Hot)
	NOX 500 ppm
	CO 500 ppm
	CO2 2.5 %

B.4-MODE STEADY STATE TEST

Mode	HC	NOX	CO	PM	BSFC	
1 (2600/90%)	0.43	9.99	0.57	0.19	164.7	[g/BHP-hr]
2 (1600/WOT)	0.24	10.92	1.49	0.36	153.7	[g/BHP-hr]
3 (1600/27%)	2.29	7.02	3.21	0.34	176.8	[g/BHP-hr]
4 (600/0%)	27.83	32.13	40.10	7.57		[g/hr]

C.SMOKE CYCLE

Test Number	A	B	C	%
1	9.6	3.5	19.5	
2	9.6	3.5	20.0	
3	8.7	3.2	17.6	
4	8.6	2.9	17.3	
5	7.6	2.7	15.9	
Average	8.8	3.1	18.0	
2s (P=95%)	1.6	0.8	3.4	
COV (2s)	18.6%	24.2%	19.6%	

D.STEADY STATE TEST

Speed [RPM]	Power [HP]	Torque [ft-lbs]	BSFC [lbs/BHP-hr]	Air Flow [CFM]	Smoke [SZ]	Inl.Dep. [in H2O]	Exh.Backpr [in Hg]
2600	173.4	350	0.363	371.5	1.1	8.0	1.80
2340	163.2	366	0.353	337.8	1.2	6.4	1.45
2080	148.2	374	0.346	294.4	1.4	4.8	1.09
1820	133.8	386	0.340	248.1	1.7	3.6	0.77
1560	120.6	405	0.344	199.1	2.4	2.4	0.74
1370	103.9	399	0.345	171.4	2.4	1.6	0.53
1170	83.3	374	0.346	138.9	2.9	0.8	0.35
910	60.1	347	0.362	97.0	3.8	0.4	0.21